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THE OAT APHIS.[2]

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INTRODUCTION.

Of the three important plant-lice attacking wheat and oats above ground, the oat aphis (*Aphis avenæ* Fab.)[3] is probably the most widely distributed and most common over its area of distribution, and is second in importance as a wheat pest, first rank being held by the so-called "green bug" (*Toxoptera graminum* Rond.), a species well known in the Southwest because of its periodic depredations. Like the "green bug," the insect under discussion is an imported species, and was probably introduced into the United States during the first half of the last century, at least previous to 1851, the date of what appears to be the first published record of its occurrence in this country.[4]

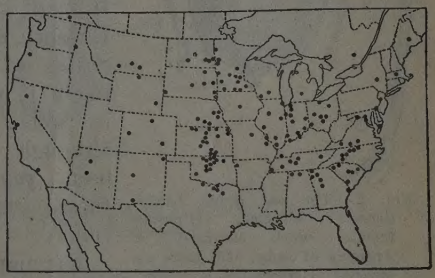

FIG. 1.—Distribution of the oat aphis in the United States. (Original.)

The oat aphis has never been considered a pest of great importance, although observations would lead to the belief that it is worthy of more consideration and study. It does not ordinarily appear suddenly in great swarms as does the "green

[1] This bulletin describes an insect found on the small grains, more especially oats. The bulletin is of interest to growers of cereals.

[2] This common name, used by some of the early writers, is adopted here, since the name European grain-aphis, used by some authors, is scarcely distinctive, all three of the common grain aphides probably being native to Europe.

[3] Specimens labeled "*Aphis avenæ* Fabr.—*A. padi* Kalt. on *Triticum vulgare*, Russia merid.," received from Dr. N. A. Cholodkovsky, of St. Petersburg, agree well with the *Aphis avenæ* of this country.

This species has the following synonyms: *Siphocoryne avenæ* Fabricius, *Siphonophora avenæ* of some authors, *Aphis mali* of some authors, *Aphis annuæ* Oestlund (included as a synonym on the authority of Mr. Theodore Pergande, U. S. Dept. Agr., Div. Ent., Bul. 44, p. 9, 1904), and *Aphis fitchii* Sanderson.

[4] Fitch, Asa. Fourth Ann. Rpt. Regents Univ. N. Y., 1851, p. 65; reprinted in Lintner, J. A., Ninth Rpt. . . . on the insects of N. Y., 1893, p. 405.

bug," although occasionally it may be found in conspicuous and alarming numbers, but it is ever present on wheat; and, especially in the fall, when it occurs at the base of the plant and on the roots, it is easily overlooked by the casual observer. However, there is no doubt that these plant-lice, even though they may not be conspicuous and apparent, weaken the plants and decrease the yield. This decrease in yield is presumably general, but may not as a rule be locally conspicuous as in the case of the "green bug," that is, not enough to be recognizable. On the whole, however, it can hardly be doubted that these little insects are responsible for the loss in this country of thousands of bushels of wheat annually.

FIG. 2.—The oat aphis (*Aphis avenæ*): Wingless viviparous female, much enlarged. *a*, Antenna of same, still more enlarged. (Original.)

DISTRIBUTION.

The oat aphis is almost cosmopolitan in its distribution, and in this respect rivals such well-known plant-lice as *Macrosiphum pisi* Kalt., *M. granarium*, and *Toxoptera graminum*. It has been found in all parts of Europe, as well as in most of the States of the United States. Quite likely it will also be found to occur in Asia, and probably in Africa, although we believe it has never been reported in literature from these countries up to the present time.

The map (fig. 1), compiled from records made by assistants in the Cereal and Forage-Crop Insect Investigations and from authentic published records, indicates the present known distribution in the United States. It will be observed that the species has not been found in the Gulf region.

DESCRIPTIVE.

On grain two forms of the oat aphis are found—the winged and wingless viviparous females. As will be explained later, it occurs on the apple where there are to be found, in addition, the sexual forms, namely, the wingless oviparous female, the winged male, and eggs. (See fig. 5.)

The *wingless viviparous female* (fig. 2) is yellowish green to olive green, often somewhat mottled. The stem mothers on apple

in the spring are more often lighter, with a darker green median longitudinal area, while those found on wheat in the fall of the year are darker, sometimes becoming greenish brown. The bases of the cornicles are surrounded, in the spring forms, with areas yellowish to orange in color, while these areas are larger and are usually orange to dark reddish in the fall and in hibernating individuals. The antennæ are about one-half the length of the body, and the cornicles, or "honey tubes," are slightly vasiform.

The *winged viviparous female* (fig. 3) has a black head and thorax, the abdomen being olive green, sometimes paler, with a row of more or less conspicuous black spots on each side anterior to the cornicles, and usually with a rusty or brownish red area about the base of each cornicle. The antennæ are black and reach a little beyond the middle of the body. The cornicles are black and slightly

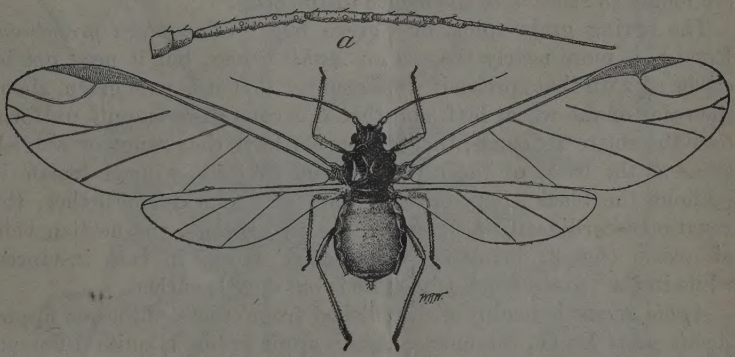

FIG. 3.—The oat aphis: Winged viviparous female, greatly enlarged. *a*, Antenna of same, still more enlarged. (Original.)

vasiform. The last branch of the median vein in the wings branches near the apex of the wing.

The *immature* aphides are paler green, but almost invariably the yellowish to pinkish areas about the bases of the cornicles are quite noticeable, although sometimes faint in very young individuals.

The *winged male* is similar to the winged viviparous female except that it is smaller and has a narrower abdomen, and the color is usually more of a dusky green.

The *wingless oviparous female* is somewhat like the viviparous female, but the abdomen is more tapering toward the tip, and the color is pale yellowish green to greenish dusky, or even has an orange tint. Rather conspicuous orange or reddish areas are present on the abdomen at the bases of the cornicles.

The *eggs* (fig. 5, *a*) are laid in the crevices of the bark or between the leaf bud and twig, and when first deposited are pale greenish, but

they soon change to shining black and retain this color until they hatch in the spring.

SPECIES LIKELY TO BE CONFUSED WITH THE OAT APHIS.

This species may be recognized in the grain field by the pinkish, orange, or reddish areas on the abdomen at the bases of the cornicles. It may also be distinguished by the wing venation, by the short, slightly swollen cornicles, by the mottled pattern of coloration of the abdomen, and in the winged form by the rows of black spots on either side. The antennæ also differ from those of other species.

The large green grain-aphis (*Macrosiphum granarium* Kirby) is larger than *Aphis avenæ* and does not have the colored areas at the base of the cornicles. These last are longer, reaching nearly to the tip of the cauda, or tail, and are more cylindrical, and the antennæ are longer in relation to the length of the body.

The spring grain-aphis, or "green bug" (*Toxoptera graminum* Rond.), is more nearly the size of *Aphis avenæ*, but it need not be confused with that species if we remember that it is pale green, about the color of the wheat leaf, and that this coloration is quite uniform over the entire abdomen; that it does not have the orange or reddish areas at the bases of the cornicles; and that the winged female is without the black spots on each side of the body. Further, the venation is ordinarily different in the two species, the median vein of *avenæ* (fig. 3) being twice branched, except in rare instances, while in the "green bug" (fig. 4) it is but once branched.

Aphis avenæ is readily distinguished from other aphides on apple. *Aphis pomi* De G., the most common apple aphis, is quite different, the wingless individuals being uniformly pale apple green with black and rather conspicuous cornicles and no trace of orange or pink on the abdomen about the cornicles. The winged individuals are similar, except that the head and thorax are shining black and the abdomen pale apple green; also the venation of the wing is different, the last branch of the median vein not dividing near the apex of the wing. This aphis spends its entire life cycle on the apple and related trees.

The rosy apple aphis (*Aphis sorbi* Kalt.) varies greatly in color from the greenish blue, pulverulent females hatching from eggs to the more or less pinkish forms. It is slightly larger than the oat aphis and does not have the pinkish or orange areas about the bases of the cornicles, although the distal end of the abdomen may be pinkish, and in some stages, such as the pupal stage of the spring migrants, the entire body may be pinkish or salmon colored. The

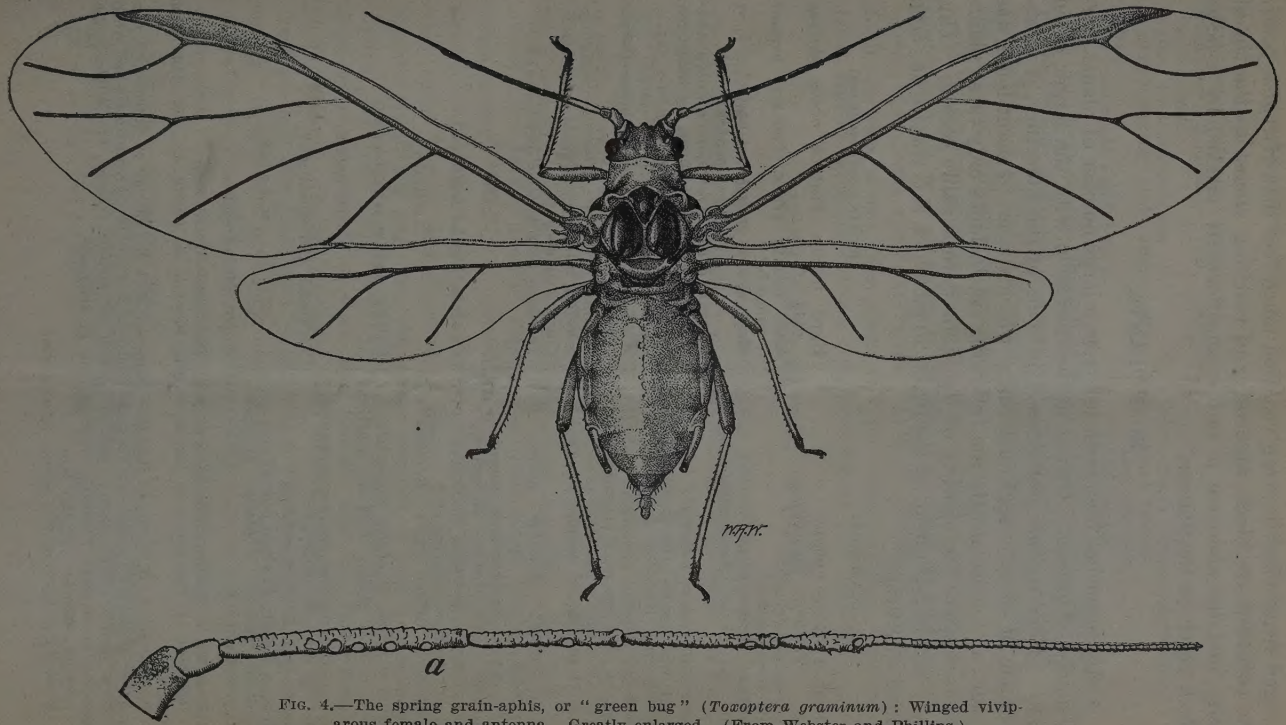

FIG. 4.—The spring grain-aphis, or "green bug" (*Toxoptera graminum*): Winged viviparous female and antenna. Greatly enlarged. (From Webster and Phillips.)

winged female has its wing venation much like that of *Aphis pomi;* the cornicles are black, tapering and reaching almost to the tip of body, and the abdomen is rather conspicuously marked by a large black patch on the dorsum.

HOST PLANTS.

Aphis avenæ has been recorded from a large number of plants, particularly of grasses. Owing to the confusion with the larger grain aphis (*Macrosiphum granarium*) in some of the literature, it is impossible in many cases to determine which species of plant-louse was meant, and consequently the following list includes only those plants in cases where the identity of the aphis is reasonably certain. This list does not include all of the plants upon which this species has been found in Europe.

GRAMINEÆ.

Wheat, *Triticum vulgare*
Triticum dicoccum [1]
Rye, *Secale cereale*
Oat, *Avena sativa*
Wild oat, *Avena fatua* [2]
Tall oat grass, *Arrhenatherum elatius* [3, 4]
Barley, *Hordeum vulgare*
Two-rowed barley, *Hordeum distichon* [2]
Wall barley, *Hordeum murinum* [4]
Timothy, *Phleum pratense*
Canada blue grass, *Poa compressa*
Kentucky blue grass, *Poa pratensis*
Annual or dwarf meadow grass, *Poa annua* [1]
Rough-stalked meadow grass, *Poa trivialis*
Crab grass, *Syntherisma sanguinale*
Upright chess, *Bromus racemosus*
Rescue grass, *Bromus unioloides*
Cheat, *Bromus secalinus* [3, 4]
Hungarian brome grass, *Bromus inermis* [3, 4]
Orchard grass, *Dactylis glomerata*
Italian rye grass, *Lolium multiflorum* [3, 4]
Perennial rye grass, *Lolium perenne* [3, 4]
Redtop, *Agrostis alba* [3, 4]
Red fescue, *Festuca rubra* [3, 4]
Sheep's fescue, *Festuca ovina* [3, 4]
Meadow fescue, *Festuca pratensis* [=*elatior*] [3, 4]

GRAMINEÆ—continued.

Hard fescue, *Festuca ovina duriuscula* [3, 4]
Reed canary grass, *Phalaris arundinacea* [3, 4]
Melic grass, *Melica bauhini* [1]
Melica penicillaris [1]
Johnson grass, *Andropogon halepensis* [5]
Broom corn, *Andropogon sorghum* var.
Sorghum, *Andropogon sorghum* var.
Koeler's grass, *Koeleria cristata* [1]
Wild rye, *Elymus geniculatus* [=*arenarius*] [1]
Virginia wild rye, *Elymus virginicus* [4]
Nodding wild rye, *Elymus canadensis* [4]
Corn, *Zea mays*
Teosinte (*Euchlaena mexicana*) [3, 4]

TYPHACEÆ.

Cat-tail, *Typha latifolia* [4]

AMMIACEÆ.

Celery, *Apium graveolens*

COMPOSITÆ.

Tickseed, *Coreopsis* sp.?

MALACEÆ.

Apple, *Malus malus*

[1] Recorded by Mordwilko as hosts of *Aphis padi* Kalt.—*avenæ* Fabr.

[2] Recorded by Fabricius; so far as known, there is no record on this plant from America.

[3] In 1909 Mr. T. H. Parks, at that time connected with the Bureau of Entomology, confined this species with various plants and found that it would breed contentedly and freely on these plants. Other plants tried, and which the aphides refused, are Muhlenbergia, *Agropyron occidentale, Panicum virgatum,* and *P. bulbosum.*

[4] Recorded here for the first time.

[5] Recorded as hosts of this species by Passerini.

MALACEÆ—continued.

Pear, *Pyrus communis*
Hawthorn, *Cratægus coccinea*, etc.
American mountain ash, *Sorbus americana*
Quince, *Cydonia vulgaris*
Double-flowering crab apple (*Malus* sp.)
Wild crab apple (*Malus* sp.)

ROSACEÆ.

Ninebark, *Opulaster opulifolius*.[1]

AMYGDALACEÆ.

Plum, *Prunus* sp.
Choke cherry, *Padus virginiana*
Wild black cherry—
Padus serotina
Padus padus

In addition to the foregoing list of food plants, Mr. Theodore Pergande lists dogwood (*Cornus* sp.), shepherd's purse (*Bursa bursa-pastoris*), and burdock (*Arctium minus*); but in each case he notes that it is, or evidently is, accidental.

Although this species, as shown, has a large number of available host plants, it is more often to be found in the fall and spring on wheat, blue grass, apple, and pear. In early summer it is frequently found on oats, wheat, blue grass, and, previous to June, on apple and pear, and in later summer on volunteer wheat and oats and on blue grass.

INJURIES AND METHOD OF WORK.

Probably no other species among the plant-lice has been so completely confused in literature as the one under discussion. Numerous reports of injury to apple, wheat, and oats have been made since its discovery in 1851, but in most instances there seems to have been some confusion in the species, and it is impossible in such cases to determine just which of several species may have been responsible for the damage. Thus in 1865 Fitch[2] described and figured a Macrosiphum on wheat, although some of his observations doubtless refer to *Aphis avenæ*. In 1879 Thomas[3] reported a plant-louse which damaged wheat considerably in Illinois in 1866 and again in 1876, but in his description he has confused two species, *Macrosiphum granarium* and *Aphis avenæ*, and there is no means by which the particular species troubling grain in the years mentioned can be identified. Again, Riley in his report for 1889[4] discusses, under the name *Siphonophora avenæ*, at least two species, and the facts relating to life history, injuries, parasites, etc., refer to more than one species; consequently this data must be ignored for the present, although the colored figures and probably most of the data contained in the article refer to *Macrosiphum granarium* rather than to the species under discussion. The same must be said of many other references to grain

[1] Recorded here for the first time.
[2] Sixth report on the insects of N. Y., 1865, p. 91–97. "*Aphis avenæ*, Fabricius."
[3] Eighth report of the State entomologist on the * * * insects of the State of Illinois, 1879, p. 51–55. "*Siphonophora avenæ*, Fab."
[4] U. S. Sec. Agr. Rpt. for 1889 (1889), p. 348.

aphides in which the author has either failed to describe the insect or its habits, or has confused two or more species in his descriptions.

On the other hand, we have one important reference to injury recognizable as that of the true *Aphis avenæ*. In Insect Life [1] Prof. F. M. Webster says:

> The wingless viviparous females of this species flock to the fields [of wheat] and on these [wheat plants] give birth to their young, which at once make their way to the roots, where they continue reproduction, sapping the life from the young plants. On very fertile soils this extraction of the sap from the roots has no very serious effect, but where the soil is not rich, and especially if the weather is dry, this constant drain of vitality soon begins to tell on the plants. Though they are seldom killed outright, these infested plants cease to grow, and later take on a sickly look * * *. It is very seldom that the affected plants fully recover, at least in autumn, and the results must be to reduce their productiveness the following year.

In January, 1891, Mr. Christian Steiffel, of Salem, Ind., reported this plant-louse as injuring wheat, causing it to turn yellow and die out in spots.

Prof. Webster received a report from Wooster, Ohio, of serious injury to wheat in December, 1898, on land subject to overflow. The wheat came up very well and remained green for about a month, after which it began to assume a brownish cast, and the warmer the weather and the more sunshine the plants got, the browner they became. In a letter dated December 4, 1901, to this bureau, Mr. J. D. Hummell, of Carroll, Ohio, writes:

> This plant louse seems to have almost completely destroyed one field of wheat in which it appeared early in the fall, and is not yet dormant, although we have had nights when the temperature was down to 15° F.

November 12, 1908, Mr. E. O. G. Kelly, of this bureau, reported this species abundant on the roots and stems of wheat at Caldwell, Kans., and doing considerable and noticeable injury to the early sown wheat.

Mr. A. A. Cooke, in a letter dated August 21, 1910, reported damage by this aphis to dwarf broom corn at Dale, Union County, N. Mex., the insect covering the plants and causing the foliage to turn a reddish color.

This insect was abundant in western North Carolina in March, 1913, reports of serious damage to wheat, oats, and rye having been received from several parties.

Numerous reports were received by this bureau from Oklahoma and northern Texas in December, 1913, and January, 1914, to the effect that the "green bug," which had ravaged the wheat fields in these areas in 1907, was again abundant and destructive to oats and wheat. Detailed examinations were made by Messrs. W. E. Penning-

[1] U. S. Dept. Agr., Div. Ent., Insect Life, v. 6, no. 2, Dec., 1893, p. 152.

ton and H. E. Smith, of this bureau, under directions from Prof. Webster. They found very few of the "green bug," while the oat aphis was present in considerable numbers. After a careful examination of the fields, the conclusions reached were that the injuries were due to one or more of three causes, namely, attacks by the oat aphis, impoverished soils, and weather conditions, particularly excessive rains during the late fall and early winter. Of these, weather conditions seem to have been the cause of the greatest amount of injury, although in certain areas the damage was more probably the result of attacks of the oat aphis. However, the parasites were in noticeable evidence everywhere, so that with normally late winter and spring weather they should prevent the aphides from becoming injuriously abundant.

As described by Prof. Webster in the foregoing quotation, the infested plants take on a yellowish or greenish yellow color, appear sickly, and cease to make any apparent growth, and since the insect works on the lower parts of the plant and is not always easily detected, the cause of the injury may sometimes be overlooked. During the summer this aphis usually feeds on the under surface of the leaves, on the stems, and in the axils of the leaves—seldom in the grain heads, as does *Macrosiphum granarium*.

CAUSES OF OCCASIONAL OUTBREAKS.

Prof. Webster[1] has made clear the reason for periodic outbreaks of the spring grain-aphis (*Toxoptera graminum*), and the usual abundance of the oat aphis in certain years may be attributed to the same cause. As in the case of the spring grain-aphis, the oat aphis breeds and multiplies at a temperature of about 40° F., or above, while the common parasite of these and many other aphides, *Aphidius testaceipes* Cress., is hardly active at a temperature less than 56° F. Consequently, mild winters and cool springs, when the temperature fluctuates between 40° and 56° F., permit the aphis to multiply, uninterrupted by attacks from their common natural enemy.

LIFE HISTORY OF THE INSECT.

The oat aphis occurs on grains and grasses throughout the summer, the spring colonies originating either from viviparous females which passed the winter on wheat, grasses, etc., or from spring migrants from apple and related trees—that is, the progeny of aphides hatching from eggs laid the previous fall on such trees. The plant-lice usually become more abundant toward fall, and as the weather becomes cooler they seek the lower parts or roots of wheat and other

[1] U. S. Dept. Agr., Bur. Ent., Circ. 85, Mar. 29, 1907, and U. S. Dept. Agr., Bur. Ent., Bul. 110, Sept. 6, 1912.

plants of the grass family and here pass the winter as viviparous females; or the winged fall migrants from grain may seek such trees as the apple, where the true sexual forms are produced, the oviparous females of this generation in turn depositing eggs on the twigs and branches, usually in the axils of the dormant buds or in crevices in the bark. (Fig. 5.)

In the latitude of La Fayette, Ind., the species commonly winters either as viviparous females on grains and grasses or in the egg stage on apple. Farther north, and especially in extremely cold winters, this species is probably unable to winter in any but the egg stage, while in the southern parts of the United States, where the winters are moderate, the aphides may live over winter as viviparous females only, no egg stage appearing.

The theory, put forth by Pergande,[1] "that the species is biennial and that the progeny of the spring migrants from the apple subsist almost exclusively upon various grains and grasses until the fall of the second year, when a generation of return migrants makes its appearance," is hardly a correct one. The writer's experience shows that while the apple may be a fall or spring host of *avenæ*, it is not a necessary alternate host, and that the species may subsist indefinitely on grains and grasses, and especially is this probably the rule in the Southern States. The species has been reared through more than 60 consecutive generations, covering a period of over two years, and through three winters on wheat, the warm greenhouse being used to carry the species through the winter months, and the line of viviparous generations could probably have been continued indefinitely but for an accident, the aphides having been killed when the greenhouse was fumigated without the knowledge of the writer.

Continuous-generation experiments were conducted at La Fayette, Ind., in 1909 by Messrs. W. J. Phillips and T. H. Parks and in 1911 and 1912 by the writer. In 1909 and 1911 the summers were unusually hot, and the experiments were not satisfactory, but in 1912 it was possible to get continuous first-born and last-born generation series without breaks. In 1909 Phillips and Parks obtained a maximum of 15 generations from May 15 to October 7 and a minimum of 8 generations in the same length of time. In 1911 a maximum of 18 generations was obtained from April 29 to October 12, and in 1912 a maximum of 23 and a minimum of 9 generations from May 3 to November 13, or a mean average of 16 generations. In the Southern States, where the species may breed throughout the winter months, a much greater number of generations would occur. In the experiments of 1909 the average number of young per female, in the 21 cages where records were kept, was 30.6; in 1911 the average for

[1] U. S. Dept. Agr., Div. Ent., Bul. 44, 1904, p. 7.

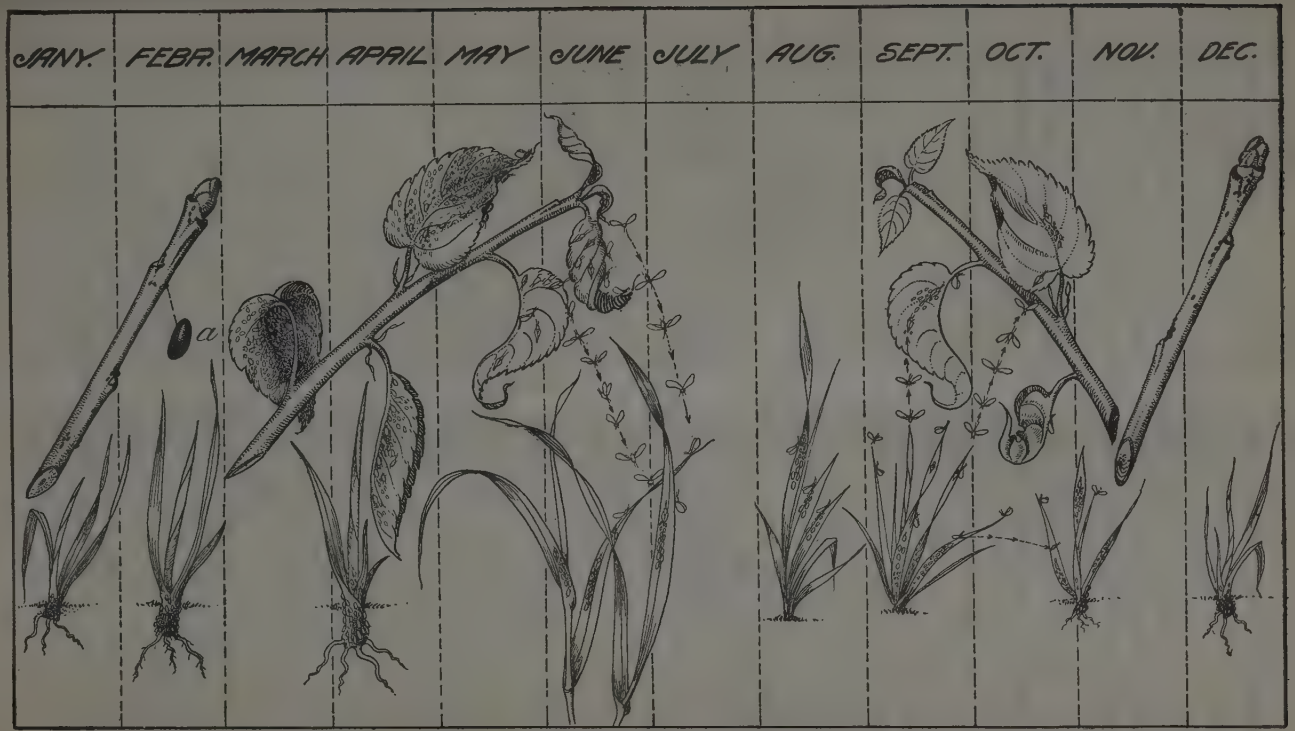

FIG. 5.—Diagrammatic explanation of the life cycle of the oat aphis. January–February, in egg (*a*) stage on apple and related trees or as wingless females on lower parts and roots of wheat and grasses. March–June, progeny from eggs hatching on apple migrate to grasses and grains. September–November, migrants return to apple, where several forms are produced. and eggs laid. Others remain on grasses or migrate to fresh grass hosts, passing the winter as viviparous females. (Original.)

17 mother plant-lice was 22.1 young; and in 1912 the average for 43 individuals was 32.7 young, with a range of from 12 to 65 young per female. There was thus an average for the three years of 32.3 young. The largest number of young produced by a single female was 103, and normally, in the cooler parts of the year, the number ranged between 50 and 60. The number of young produced per day ranged from 1 to 8 per female, and the length of the period from birth to maturity varied from 6 to 15 days and averaged about 8½ days, excepting in late fall, when the length of time was ordinarily much greater. According to the numerous tests the species molts but four times, as do other species.

It will be seen from the foregoing that this species, like many other plant-lice, is quite prolific, although not so prolific as the "green bug" (*Toxoptera graminum*). It is computed that in 15 generations, averaging 30 young per female, the progeny from a single individual, providing all lived and reproduced, would cover almost the entire land area of the world, or, if packed 256 to the square inch and piled 25 high to the inch (6,300 to the cubic inch), would cover the entire State of Texas to a depth of 7 inches. Fortunately plant-lice are delicate insects, being highly susceptible to rains and inclement weather, and are preyed upon by many predaceous and parasitic animals, as well as being subject to fungous diseases.

In 1879 Dr. Cyrus Thomas[1] aptly discusses the winter habits of the wintering viviparous females in the following words:

> When winter appears they move down toward the ground, some of them, at least, entering the soil and feeding upon the sap of the roots. At any rate, I find the apterous ones at this time working upon the roots, but at the same time I find a winged individual above ground. I have also observed them heretofore at the root of the wheat, late in winter, while snow was on the ground; and what somewhat surprised me, I found them busy at work under the snow, and the apterous females bearing well formed larvæ.

There are numerous office records in which the occurrence of this plant-louse is reported on wheat and grasses during the winter months, but the following individual record will substantiate the belief that the insect may survive even rather severe winters as viviparous females. At Wellington, Kans., Mr. T. H. Parks found adult wingless viviparous females of the oat aphis on wheat roots April 9, 1910, and these had undoubtedly passed the winter on wheat, or were the direct progeny of overwintering females. The winter of 1909–10 was an unusually severe one at Wellington, according to Mr. E. O. G. Kelly, the ground becoming frozen early in December, 1909, and remaining frozen until February, 1910, after which

[1] Eighth Rept. State Entomologist, Ill., 1879, p. 53.

it alternately froze and thawed until March, 1910, the weather being so severe that 50 to 75 per cent of the wheat in that vicinity was killed by the cold.

Sometimes these winter root forms are attended by ants, as has been observed by Prof. Webster and the writer. The forms which go to apple migrate early in October in the latitude of La Fayette, Ind., and usually fully a month later in the latitude of northern Oklahoma. In the rearing cages it has never been possible to get the forms from wheat to migrate to apple, the failure doubtless resulting from the use of too small cages. On the other hand, there was no difficulty in getting the spring migrants to go to wheat and there continue to reproduce throughout the summer from apple shoots, even in small lantern globe cages.

NATURAL CHECKS.

Like most plant-lice of the genus Aphis, *avenæ* is freely attacked by various parasitic and predaceous animals, principally insects, and doubtless these are responsible for the usual control of this pest.

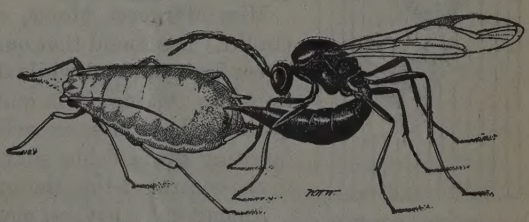

FIG. 6.—*Aphidius testaceipes* ovipositing in the body of the spring grain-aphis. Enlarged. (From Webster.)

Among the internal parasites, Fitch[1] has recorded *Toxares triticaphis* Fitch, (*Praon*) *Aphidius avenaphis* Fitch, and *Allotria tritici* Fitch, but it is probable that he reared these from *Macrosiphum granarium* rather than from *Aphis avenæ* as was supposed by Mr. Pergande.[2] In 1894 F. M. Webster[3] reports rearing *Pachyneuron micans* Howard and (*Lysiphlebus*) *Aphidius testaceipes* Cresson (*tritici* Ashmead). The latter species (figs. 6 and 7) is the one which ordinarily holds the spring grain-aphis (*Toxoptera graminum*) in check, and doubtless is likewise beneficial in preventing undue multiplication in *avenæ*. Mr. Theo. Pergande[4] reared another species of *Aphidius* (*A. nigriceps* Ashmead) in considerable numbers from this aphis.

Among the predaceous insects Pergande[4] has reared a common syrphid fly (*Syrphus americanus* Wiedemann) (fig. 8); the writer has reared a species of Aphidoletes from larvæ feeding on *Aphis*

[1] Sixth Rpt. on the noxious and other insects of the State of N. Y., 1865, pp. 98–112.
[2] U. S. Dept. Agr., Div. Ent., Bul. 44, 1904, p. 13.
[3] Ohio Agr. Expt. Sta., Bul. 51, 1894, p. 117.
[4] Op. cit.

avenæ at La Fayette, Ind., and Washburn [1] says that this plant-louse is attacked by a "red mite." Of the ladybird beetles which attack this aphis, Fitch mentions *Hippodamia parenthesis* Say, *Coccinella 9-notata* Herbst, and *Coccinella 5-notata* Kirby, although it seems probable that Fitch was dealing with a different plant-louse, and he may not have observed them feeding on the oat aphis. At different times assistants of the Cereal and Forage-Crop Insect Investigations have observed the following ladybird beetles, or their larvæ, feeding on the oat aphis in various parts of the United States: *Cycloneda munda* Say, *Coccinella 9-notata* Herbst, *Megilla maculata* DeG., *Scymnus* sp., and *Hippodamia convergens* Guér. (fig. 9), the last species being by far the most abundant, and consequently the most useful of the coccinellids in the control of the aphis.

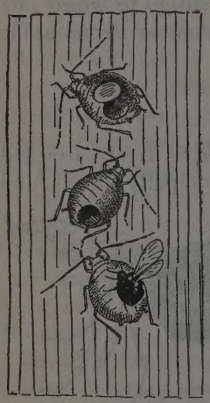

FIG. 7.—Dead aphides, showing holes from which the matured parasites of *Aphidius testaceipes* emerge. The top figure shows the lid still attached, but pushed back; the bottom figure shows the parasites emerging. Enlarged. (From Webster.)

In addition to the foregoing enemies, the larvæ of several species of lace-wing flies (Chrysopidæ) are known to feed upon this aphis.

Miss Margaret Morse, of Worcester, Mass., (in litt.) has found that quails eat these aphides in confinement, and while definite field observations are lacking, it is quite probable that the quail, or bobwhite, as well as other birds frequenting grain fields, plays an important part in the control of this and other grain aphides.

Among other natural agencies which assist in holding the aphis in check are fungous diseases. These, like most fungi-attacking insects, thrive best under moist conditions; hence the diseases commonly attacking plant-lice are most prevalent and useful in moist seasons. Rains likewise have a beneficial effect, particularly "driving" rains.

Webster,[2] in his Ohio report, "suspects" two minute insects, *Gonatocerus brunneus* Ashm. [MS.] and *Polynema longipes* Ashm. (*Cosmocena citripes* Ashm.) as destroying eggs of *avenæ*, but this observation has apparently never been authenticated.

REMEDIAL AND PREVENTIVE MEASURES.

As in the case of the well-known spring grain-aphis, or "green bug" (*Toxoptera graminum*), it is practically impossible to control

[1] Twelfth Rpt. State Entomologist of Minn. for 1907 and 1908, Dec., 1908, p. 50.
[2] Op. cit., p. 117.

the oat aphis after it has once gained much headway in numbers and diffusion, but by proper precautions it is possible to prevent serious outbreaks.

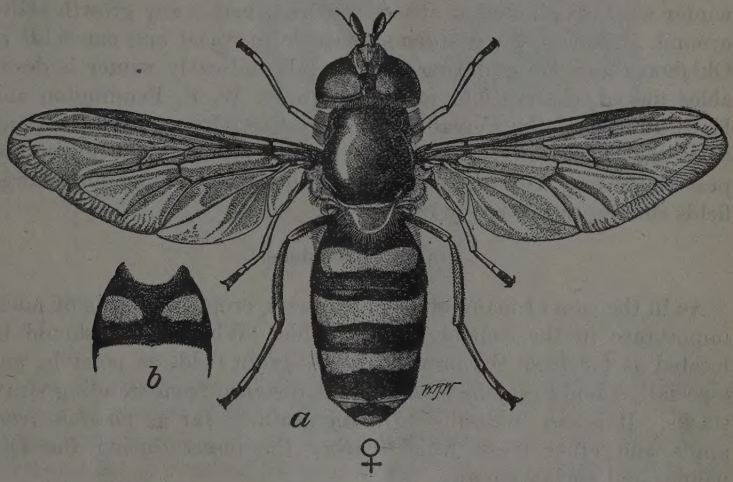

FIG. 8. *Syrphus americanus,* whose larva destroys the oat aphis. *a,* Female fly; *b,* second abdominal segment of male. Enlarged. (From Webster and Phillips.)

DESTRUCTION OF BREEDING PLACES.

As has been observed by the writer and other assistants of the Cereal and Forage-Crop Insect Investigations, the plant-louse under discussion thrives best in rank-growing wheat, for instance in spots where manure piles or straw stacks have stood, as well as in the vicinity of straw stacks where the growth of grain is usually luxuriant. In fact, observations show that the latter place is the usual center of infestation, for during the colder winter months the plant-lice may be found here when it is impossible to locate them elsewhere. Such locations also provide much better protection from inclement weather, and reproduction may continue, more or less, throughout the winter. Therefore it is evident that if the growth about straw

FIG. 9.—The convergent ladybird (*Hippodamia convergens*), an enemy of the oat aphis: *a,* Beetle; *b,* pupa; *c,* larva. Enlarged. (From Chittenden.)

stacks be plowed under or otherwise destroyed late in fall, the aphides harbored thereon will be destroyed. In some cases it may be desirable to destroy this vegetation even earlier; that is, before the winter wheat is planted or at least before it makes any growth above ground. Likewise the pasturing of cattle in wheat and oat fields in Oklahoma and Texas during the late fall and early winter is desirable; indeed, observations made by Messrs. W. E. Pennington and H. S. Smith, of the Cereal and Forage-Crop Insect Investigations, show that where this procedure had been followed, the grain was practically free from the oat aphis, although adjoining unpastured fields showed rather heavy infestation.

CULTURAL METHODS.

As in the case of many other grain pests, crop rotation is of much importance in the control of this aphis. Wheat fields should be located as far from the previous year's grain fields as possible, and especially should they be planted some distance from standing straw stacks. It is also advisable to plant grain as far as possible from apple and other trees, which harbor the insect during the fall, winter, and spring months.

SPRAYING.

Direct applications are hardly practicable in grain fields, but where only small areas are badly infested spraying with blackleaf-40 at the rate of 1 part of this insecticide to 900 parts of water, plus 1 pound of soap to each 100 gallons of spray liquid, will doubtless prove efficacious, providing the application is thorough.

Another method which might be adopted in localities where the aphides freely migrate and deposit eggs on apple, is spraying such trees early in spring before the eggs hatch, preferably just previous to their hatching and while the trees are yet in a dormant condition, with commercial lime-sulphur mixture at the rate of 1 part of the mixture to 8 parts of water.

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